FRUIT AND VEGETABLE PRESERVATIVE

This invention relates to the preservation of minimally processed fruits and vegetables and flowers, particularly cut and peeled or juiced fruits and vegetables.

Background to the Invention

Most fruits and vegetables are subject to discolouration and spoilage once they are cut and peeled. This is usually due to enzymatic and bacterial action.

Patent application WO 97/16976 discloses a method of storing cut apple pieces in which whole apples are washed in chlorinated water to inactivate microorganisms, the apples are then cored, peeled and sliced and immersed in an ascorbic acid solution having a pH of 2.2 to 2.7 and are then drained and stored in modified atmosphere containers.

Patent application WO99/34683 discloses a method of treating cut fresh vegetables by dipping in a solution containing calcium ions and ascorbate or erythorbate ions.

USA patent 6054160 treats cut apples with a solution containing L-cysteine, sorbitol, and calcium chloride and then stores them in a modified atmosphere pack.

These treatments provide a shelf life of up to 2 weeks but in practice this is not long enough.

It is an object of this invention to provide an improvement in shelf life for minimally processed fruit and vegetables.

Brief description of the invention

To this end the present invention provides a process of extending the useful shelf life of minimally processed fruits and vegetables which includes the step of treating the fruits and vegetables with a flavonoid compound.

This invention is partly predicated on the discovery that the presence of flavonoids inhibits the enzymatic and bacterial action that leads to discolouration and spoilage. The flavonoid may be added to a solution sprayed or dipped on to the processed fruits or vegetables or added to the fruit or vegetable juice.

Flavonoids such as proanthocyanidin have been identified as antioxidants and recommended as food additives for nutriceutical use but not to prevent deterioration in minimally processed fruits and vegetables.

It is preferred that an anti oxidant such as ascorbic acid, erythorbic acid, lipoic acid including alpha lipoic acid, be present with the flavonoid compound. It is believed that these compounds act synergistically with the flavonoid compounds to inhibit oxidation of the minimally processed fruits and vegetables. Some fruits and vegetables have an adequate content of ascorbic acid and for these addition of a flavonoid is sufficient.

Throughout this specification minimally processed means the steps of processing raw, uncooked fruits, nuts and vegetables for storage and/or transport prior to eating or further processing. This includes peeling, coring, slicing and juicing.

Throughout this specification flavonoid means a polyphenol compound of the type having at least two aromatic rings which occur widely in the plant kingdom and inhibits oxidation. These compounds may also form polymeric compounds with the flavonoid repeating unit .The term flavonoid as used throughout this specification includes individual flavonoids, mixtures and plant extracts having a high flavonoid content.

The fruits to which this invention is applicable include oranges, mandarins, grapefruit, tangerines, tangellos, pomellos, kiwi fruit, mango, pineapple, apricots, strawberries, blackberries, raspberries, mulberries, cherries, blueberries, grapes, figs, peaches, nectarines, apples, pears, nashi, plums, tamarillo, cantaloupe, guavas, lychees, rumbutans, melon, passionfruit, avocado and mangosteen. Nuts such as chestnuts may also be treated

The vegetables which can be treated according to this invention include broccoli, brussel sprouts, carrot, cabbage, capsicum, chili, chocos, cauliflower, celery, lettuce, garlic, ginger, green beans, shelled peas, asparagus, corn, pumpkin, mushrooms, snow peas, zucchini.

The fruit or vegetables are sprayed or immersed in the solution containing the flavonoid and excess solution is removed from the surfaces and the products are packaged in the usal way for minimally processed fruits and vegetables.

Fruit juice can be preserved by the addition of flavonoids to the juice. Navel oranges are usually not preferred for juicing because the juice acquires a bitter taste. The addition of a flavonoid to navel orange juice inhibits the development of this bitter taste. In preparing the fruit juice the pulp is usually separated from the serum and then recombined to form the juice. The flavonoid may be added to either the pulp or the serum or both but preferably to the pulp.

In another aspect of this invention the present invention provides a preservative composition for use in preserving minimally processed fruits and vegetables which composition includes a flavonoid mixed with a food grade anti oxidant, preferably selected from one or more of ascorbic acid, erythorbic acid, lipoic acid including alpha lipoic acid and salts thereof such as sodium, potassium and calcium ascorbate. This is preferably a powder but may be a liquid concentrate that can be diluted in water, tea infusion or a fruit juice to form the dipping solution. The ratio of flavonoid to antioxidant is usually from 1:50 to 1:150 by weight. This mixture is then diluted in 30 to 50 times its weight in water or fruit juice. The flavonoid content in the dipping solution or in juiced fruit or vegetable is preferably from 0.01wt % to 0.1wt%. In addition to the flavonoid, alpha lipoic acid may also be added to the dipping solution or fruit or vegetable juice as an additional antioxidant in amounts from 0.0005 wt % to 0.005wt %.

The flavonoid may be any available compound or extract. The group takes its name from the compounds flavone, flavonol, flavanone but also includes chalcones, anthocyanidins, proanthocyanidins, isoflavonoidsand polymeric forms of these compounds. Flavonoids are available as plant extracts and are an effective source for use in this invention. A preferred flavonoid source is an extract from *pinus radiata* or *pinus pinasta* [maritime pine] marketed as Enzogenol™ and Pyncogenol™ respectively. Enzogenol contains about 38% polymeric proanthocyanidins, 25% oligomeric proanthocyanidins and 22% monomer, dimer and trimer proanthocyanidins. Grape seed extract and grape seed oils are another favoured source. Also may be mentioned Quercitin, a flavonoid present in grapes, apples, broccoli and onions, acerola from cherries, hesperidin, rutin and any plant extracts rich in flavonoids such as citrus seed extract, cranberry extract, juniper berry extract, rose hip extract.

The dipping or spraying solutions may contain other ingredients for flavour and to assist the action of the flavonoids. Acid to maintain a low pH for antibacterial effectiveness is a useful ingredient and any food grade acid such as citric acid may be used. Alternatively acidic fruit juices, such as pineapple juice, may be used. Other ingredients may include sugar, water sanitisers such as colloidal silver, or microhydrin.

Detailed description of the invention

Preferred formulations and treatments for particular products will be described with reference to particular fruits and vegetables

Oranges

The orange is peeled, cored and the outer membrane is removed.

The dipping solution is made proportionately to the formula:

Unsweetened pineapple juice	400ml
Sugar	400g
Grape seed oil	20ml

The sugar and pineapple juice are boiled together for 3 minutes cooled and the grape seed oil is added.

The peeled and cored orange is immersed for about 3 minutes and then the excess solution is allowed to drain and the orange can be packed into a suitable display container.

An alternative formula may replace the grapeseed oil with about 60mg of pyncogenol™ or enzogenol ™ which are pine bark extracts containing a high is concentration of flavonoid compounds including polymeric proanthocyanidins.

A preferred formula is

Unsweetened pineapple juice 400ml boiled for 3 minutes with 400g sugar then cooled. To which is added 20ml grapeseed oil and 60mg enzogenol.

Shelf life trials of the oranges so treated indicated that even after eight weeks the taste and flavour remained fresh.

Orange juice

Navel oranges were juiced and three samples were produced as shown in table 1

Sample	Navel juice	pyncogenol ™	enzogenol ™
1	200ml		
2	200ml	20mg	
3	200ml		40mg

The control sample 1 showed distinct bitterness after two weeks storage but the samples 2 and 3 were still tasting fresh and sweet after three weeks.

A preferred flavonoid for orange juice may be selected from citrus bioflavonoids, tangeretin, hesperidin,rutin or mixtures thereof.

In addition to the flavonoid alpha lipoic acid may also be added to the orange juice as an additional antioxidant in amounts from 0.0005 wt % to 0.005wt %of the orange juice.

A preferred additive for orange juice is :

30 mg alpha lipoic acid

5mg Folic acid

30mg pycnogenol or grape seed extract or a mixture.

100mg of citrus bioflavonoids

25mg hesperidin

50mg Rutin

and 200 - 250mg zinc glutonate

This formula is particularly effective with navel oranges. Navel orange juice after eight weeks storage had a fresh citrus smell and bright orange colour and was still pleasant tasting with no aftertaste.

Apples

A dipping solution for apples is prepared by boiling 400ml of water with 20g of sugar for three minutes and allowing to cool. To the sugar solution is added 20mg of Enzogenol™ and 60ml of lemon juice or 20 mg ascorbic acid.

Granny smith apples which had been peeled nd sliced are immersed in this solution for about 10 minutes while softer apples are immersed for 8 minutes. The apples are removed drained and packed for cold storage . After 3 weeks the pieces are still white and crisp.

A more complete formula for apples is prepared by using a dry mix of ascorbates and flavonoids containing

600mg magnesium ascorbate

750mg calcium ascorbate

600mg potassium ascorbate

25mgs of acerola

12mgs of rose hip powder [rosa canina]

25mgs bioflavonoids

37mgs hesperidin

50mg rutin

6mg maritime pine bark extract .

This powder is added to a solution of 600ml water which has been boiled for 3 minutes with 200g of sugar ,allowed to cool and mixed with 50mls of unsweetened pineapple juice.

By immersing the peeled and quartered apples in this solution for 12 minutes followed by draining and packing a shelf life of 3 weeks was achieved.

Using this formula it is possible to prolong storage of the apples by allowing the peeled and quartered apples to remain in solution or to be immersed and drained alternately for an hour repeatedly for as long as needed until the pieces are to be packed for transport.

A comparative test was carried out with apples in which group 1 were treated with a solution from which the pineapple juice and ascorbates had been omitted while group 2 were treated with the complete solution but without the addition of flavonoids.

After 17 days storage the group 1 apple slices were still normal in colour and crisp while the group 2 apple slices were rated as fairly crisp and brown in appearance.

Apple Juice

Apples were juiced and three samples were produced as in table 2

Sample	Apple Juice	Ascorbic acid	pyncogenol ™	enzogenol ™
1	200ml			
2	200ml	5g	20mg	
3	200ml	5g		40mg

The juice of sample 1 oxidised and became brown. After 4 weeks the condition of samples 2 and 3 were still fresh.

A preferred apple juice formula used per lire of fresh apple juice consists of

200ml of pure water

5g calcium ascorbate,

1mg Quercitin

20mg enzogenol or 50mg grapeseed extract.

OTHER FRUITS

Formulae for some other fruits are set out in table 3

The water and sugar are boiled for 3 minutes then cooled and the remaining ingredients are added.

The fruits are peeled if needed and cut to remove seeds if necessary and the prepared fruits are immersed for 3 to 8 minutes on average. Strawberries are preferably dipped quickly and packed.

Modified atmosphere packaging was used for all the packed fruit.

Table 3

FRUIT	Solution	Ascorbic acid source	Flavonoid	other
Nashi	400ml water+ 100g sugar	15ml lemon juice	20mg enzogenol	
Honey dew melon	400ml water+ 100g sugar	10ml lemon juice	10mg enzogenol	
Pineapple	300ml water+ 200g sugar	7.5 g calcium ascorbate +30ml lemon juice	60mg enzogenol	10ml sanitizer
Canteloupe	500ml water	250mg calcium ascorbate	6gms maritime pine extract	5ml sanitizer
Strawberries	500ml water+ 5ml fruit sugar		5mg rosehip powder	5ml sanitizer +125 mgsilica hydride
Nectarines or Apricots	400ml water+ 200g sugar	5 g calcium ascorbate +45ml lemon juice	12mg maritime pine extract or 60mg enzogenol	5ml sanitizer +125 mgsilica hydride
mangosteens	200ml water+ 10g sugar+ 125ml unsweetened pineapple juice	125ml grapefruit juice	60mg enzogenol +25ml grapeseed oil	5ml sanitizer +125 mgsilica hydride
Durian	50ml unsweetened pineapple juice+ 50g sugar	5 g calcium ascorbate	50mg bioflavonoids + 25mg hesperidin+25mg rutin+60mg enzogenol	10ml grapeseed oil or glycerin
Chestnuts	200ml water +5mg green tea	5g calcium ascorbate	90mg enzogenol	
Chestnuts	400ml water	60ml lemon juice	60mg enzogenol	
peaches	350 ml water +150g sugar	5g calcium ascorbate + 40ml lemon juice	12mg maritime pine extract or 60mg enzogenol	5ml sanitizer +125 mg silica hydride

Using these formulas in the process of this invention extended the usual shelf life of all these fruits to beyond 3 weeks.

The fruits treated with these formulae can also be used in fruit salads. The apple formula can be used with salads containing two or more of nashi, guava, watermelon, honey dew melon, kiwifruit and starfruit and peaches.

Vegetables

A wide variety of minimally processed vegetables can be treated according to this invention . the apple formula may be used or one of the formulae shown in table 4.

The solution is boiled for 3 minutes and then the other ingredients are added. Immersion of the peeled and/or cut vegetables is for 3 to 8 minutes as required and then drained prior to packaging.

Table 4

formula	Solution	Ascorbic acid source	Flavonoid	other
1	200ml water+	5g ascorbic acid	50mg grapeseed oil or enzogenol	5ml grapeseed oil
2 [celery]	200ml water 5mg green tea extract	5-10 g calcium ascorbate	60mg enzogenol	
3	200ml water	50mg alpha lipoic acid	25mg hesperidin	5mg citric or tartaric acid +2mg folic cid
4	6juniper berries in 150ml water	5 g calcium ascorbate	500 I U d-alpha tocopherol	5mg zinc gluconate

Formula 1 is used with carrots that have been sliced or diced

Formula 3 was particularly suitable for potatoes, suedes, parsnip, broccolli, cauliflower, pumpkin, chocos, chopped beans and shelled peas.

The shelf life of vegetables treated with these solutions by immersion for 5 to 10 minutes followed by drying was more than 3 weeks.

Lettuce

Whole lettuce is washehed in pure water and the then 25ml of the following formula was injected into the stem of the lettuce.

5ml folic acid 5 g calcium ascorbate 60mg of enzogenol

2.5g of barley green or spiralina chlorophyll extract.

A shelf life in excess of 21 days was achieved with this method.

Cut Flowers

The vegetable formula or 5g of potassium ascorbate and 20mg of enzogenol in 2 litres of water has been found to maintain the freshness of cut flowers when used as the solution in vases.

From the above it can be seen that this invention provides a unique way of using naturally occurring compounds to extend the shelf life of minimally processed vegetables. Variations and additions to the formula and process can be made without departing from the inventive concept as disclosed herein.